

# EXHIBIT G



**ESi**

# Investigative Report

**Harris (Melba) v Delta Air Lines, Inc.**

ESi Matter: 88596



5575 Tech Center Drive, Suite 115  
Colorado Springs, CO 80919

# Investigative Report

**Harris (Melba) v Delta Air Lines, Inc.**

ESI Matter: 88596

**Report Prepared For:**

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27777 Franklin Rd., Suite 2500  
Southfield, MI 48034

**Submitted by:**

A handwritten signature in blue ink that reads "David M. Fortenbaugh".

David M. Fortenbaugh, Ph.D.  
Senior Consultant

1/9/2023

\_\_\_\_\_  
Date

**Technical Review by:**

A handwritten signature in blue ink that reads "Peggy A. Shikata".

Peggy A. Shikata, P.E.  
Senior Consultant  
Michigan, P.E. | Expires: October 28, 2024

1/9/2023

\_\_\_\_\_  
Date

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## Introduction

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Engineering Systems Inc. (ESI) was retained by the firm of Taft, Stettinius & Hollister to provide technical assistance in the analysis of an incident in which Ms. Melba Harris (age 53) was reportedly injured on February 9, 2020, after hot coffee that she had ordered spilled onto her lap while aboard a Delta Air Lines flight traveling from Tokyo, Japan to Detroit, Michigan, United States.

This report will focus on the human factors and ergonomics related to the subject incident. "Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance ... Human factors is concerned with the application of what we know about people, their abilities, characteristics, and limitations to the design of equipment they use, environments in which they function, and jobs they perform."<sup>1</sup>

Prior to the issuance of this Investigative Report, the materials listed in Appendix A have been received and reviewed by ESI. The items referenced in Appendix A and footnoted throughout the report, as well as the investigation/analysis discussed in this report, may be utilized for trial exhibits.

David M. Fortenbaugh, Ph.D. is a salaried employee of ESI, a nationwide, multi-disciplinary professional engineering and scientific consulting firm. ESI currently charges \$290 per hour for his time on this project. A summary of Dr. Fortenbaugh's qualifications are set forth in his CV (Appendix B). He has a broad range of specialization and training in human factors, ergonomics, and biomechanics. He has a B.S. in Biomedical Engineering from Yale University, a M.S. in Movement Science with a specialization in biomechanics from Barry University, and Ph.D. in Ergonomics from the University of Miami.

As a consultant with ESI, Dr. Fortenbaugh has forensically investigated over 800 accidents, hundreds of which have involved human factors and ergonomics issues. This has included accidents involving spills of hot liquids and burn/scald injuries. Dr. Fortenbaugh is an active member of several professional societies, including the Human Factors and Ergonomics Society (HFES), the American Society of Testing and Materials International (ASTM), and the American National Standards Institute (ANSI). He serves on various ASTM and ANSI committees, working with other industry leaders to develop consensus safety standards. Dr. Fortenbaugh has been qualified to testify in court as an expert in human factors and ergonomics. A list of cases in which he has testified in deposition and/or trial in the last four years is provided in Appendix C.

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<sup>1</sup> <https://www.hfes.org/About-HFES/What-is-Human-Factors-and-Ergonomics>



## Background

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This section of this report provides a brief outline of materials received as related to ESI's analysis of the subject incident. This outline is not intended to address the accuracy or consistency of the information received but rather to provide context for this report.

## Discovery Responses

A boarding pass for Ms. Harris on the day of the subject incident indicates she was seated in 44A on Delta Flight 276 from Tokyo to Detroit.<sup>2</sup>

Ms. Harris and her counsel provided answers to Defendant's First Interrogatories and Requests for Production of Documents on January 14, 2022. She described the subject incident:

*"I was seated in my seat next to the window. During ... breakfast service, I was asked whether I wanted coffee. The flight attendant served me coffee in a cup. I attempted to take a sip, but it was too hot, so I placed the cup down and into the indentation on my tray table. A very short time later, the coffee cup tipped over and coffee spilled onto my lap, causing the burns which are the subject of this lawsuit. I was wearing black workout (sweat) pants, and the area where the coffee spilled became very painful. I immediately got up and attempted to get help from the flight attendant."*

Ms. Harris further stated that she "received second degree burns to a large area of [her] left thigh." Photographs have been provided by Ms. Harris that document this injury (**Figure 1**). It is her belief that she "did not cause or contribute to the accident in any manner" but rather that "the coffee was served at too high of a temperature and that a cover for the container was not offered or provided."



**Figure 1. The burn injuries to Ms. Harris**

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<sup>2</sup> Harris 53



## Deposition of Melba Harris

Ms. Harris was deposed on December 15, 2022. She testified that she was a coffee-drinker but did not drink coffee every morning at home. When she would make coffee, she would get hot water from a teakettle and mix the water with powdered coffee. Other than having coffee on airplanes, she would also occasionally get coffee from McDonald's.

Ms. Harris testified that she had never spilled a hot beverage in her life. However, she did recall once burning her tongue with hot soup after heating it in the microwave at home. She did not know the temperature of the soup when it burned her tongue. She did not know the usual or expected range of temperatures for brewing or serving coffee. Ms. Harris was aware of the possibility that served food or drink would be hot enough to burn her skin, though it was her expectation that every cup of coffee served to her would be at a temperature such that "it's not going to burn my skin." She further testified that the temperature of the subject cup of coffee was too hot because it caused a burn on her leg.

Historically, Ms. Harris would fly "at least once a year," though sometimes more frequently. In the past 10 years, she flew with Delta, American, United, and Korean Airlines. She would fly to the Philippines "maybe every other year" to visit family. The subject flight was the second leg of a return trip from Manila. It was her custom to drink coffee on these flights to and from the Philippines, "usually in the morning during breakfast."

Ms. Harris did not recall in which row she was seated during the subject flight, though she recalled she was in the coach class and was in a row with three seats where she was by the window with two people to her right. She did not know either of those people. She was wearing "velvety" sweatpants, a long-sleeve shirt, and a vest. Ms. Harris recalled two food and beverage services on the subject flight, with the first one being just drinks and snacks and the second being breakfast. The subject incident occurred during the second service.

The flight attendants pushed a beverage cart down the aisle, but Ms. Harris did not remember where they started with the cart for the service around the time of the subject incident. She did state that "they did not come to my row right away." The attendants started somewhere else before making it to her row. She remembered seeing "the flight attendant maybe two rows ahead of me" and estimated it was "maybe five to ten minutes" later than they arrived at her row. She believed the attendant was facing the back of the airplane and pushing the cart towards the back of the plane at the time. At the time of the incident, Ms. Harris believed the cabin lights were illuminated. It was "not dark."

Ms. Harris did not recall whether the seat in front of hers was reclined at the time of the subject incident. She had a tray table, and it was down when she was served the subject cup of coffee. She believed the tray was only able to rotate down and could not also slide forward and back. When Ms. Harris was served the subject cup of coffee, she already had a sandwich, fruit, spoon, fork, and napkin on the tray. "They served food first, and then they served the beverage after."

Ms. Harris asked the flight attendant for a cup of coffee. "She poured [it from] the coffee canister [into] the cup, and then she gave it to me." Ms. Harris reached out with her right hand, took the cup from the attendant, and placed it on her tray in the circular indentation for beverages. This handoff occurred with "no problem," and neither said anything to the other during the exchange.



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The coffee was served about “three-fourths full” in a small paper cup with no lid. Ms. Harris testified that she had never had a lid on any cup of coffee on any flight in the past 10 years. She did not ask for a lid and did not expect one.

When Ms. Harris first received the cup, before even placing it on the tray, she smelled the coffee and felt the cup to get a sense of its temperature. “As far as I remember, I [thought it was] too warm [and] that I [needed] to put it down.” She initially testified that she never put the coffee to her mouth. She later clarified in her deposition that “I did not drink it, I [sipped] it.” She decided when taking that sip that it was “too hot.” Ms. Harris testified that she understood that some people liked their coffee hotter than others. She let the coffee cool for “probably a minute or two.”

While still sitting on the tray, “all of a sudden, the cup tilted, and then it [overflowed] on the tray, and then it went [into] my lap.” She did not know why the cup tipped over. She believed the cup tipped such that coffee only came towards her, with no coffee spilling to the sides of the tray or back towards the seat in front of her. “I got a second-degree burn” as a result of the subject incident. This was the only injury Ms. Harris claimed to have sustained from the incident.

## Selected Medical Records

Ms. Harris’ records from the Beaumont Urgent Care and the Henry Ford Health System from shortly after the subject incident were reviewed by ESI. A record from February 24, 2020, approximately two weeks after the subject incident, states that “she suffered second degree burns when traveling home from Japan on February 9<sup>th</sup>.” It further states in the “assessment/plan” that Ms. Harris was diagnosed with “second degree burns of bilateral thighs.”

The take-home instructions provided to the discharged patient classified a second degree burn as a “partial thickness burn. Your skin contains 3 layers. A second-degree burn occurs when the first layer and some of the second layer are burned. This type of burn usually heals within 2 to 3 weeks with some scarring.”



## Investigation and Analysis

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### Coffee Temperatures for Brewing, Serving, and Consumption

*Ms. Harris has alleged that the coffee she was served by Delta was too hot, but she did not know the temperature coffee is typically brewed, served, or consumed.* It is, therefore, important to gain a better understanding of these typical temperature ranges. "The brew temperature is widely considered a key parameter affecting the final quality of coffee, with a temperature near [199 degrees Fahrenheit] often described as optimal."<sup>3</sup> The National Coffee Association provides a guide on how to brew coffee, noting that "your brewer should maintain a water temperature between 195 to 205 degrees Fahrenheit for optimal extraction. Colder water will result in flat, under-extracted coffee, while water that is too hot will also cause a loss of quality in the taste of the coffee."<sup>4</sup>

An internal document from Delta Air Lines outlines procedures for flight attendants to prepare coffee and hot water.<sup>5</sup> In part, it provides instructions for how to use the coffee maker onboard:

*"Raise the brew handle and remove the brew cup. Verify that the brew cup is clean and free of coffee grounds. Place a pillow pack, seam down, on top of the screen in the brew cup. Do not fold corners of pack. Press the Brew button. Brewing will occur only when the water is within the set maximum nominal operating range of approximately 188° F to 196° F (86° C to 91° C)."*

With an industry-standard brewing temperature established, it is next incumbent to recognize the temperature at which coffee is typically served and then ultimately consumed. It is well-understood that coffee usually "rapidly [cools] after being served."<sup>6</sup> One study plotted heat loss of various common hot beverages over a 10-minute period (**Figure 2**).<sup>7</sup> An essentially uniform pattern of heat loss was seen across beverage types, with the primary variable influencing beverage temperature being the initial starting temperature. Another study, looking at brewing temperatures as they relate to optimal taste, served participants coffee at  $149 \pm 2$  degrees Fahrenheit.<sup>8</sup> A study analyzing the dispensing and serving temperatures of coffee machines in private homes and in the food service industry found a median temperature of 167 degrees Fahrenheit.<sup>9</sup> A 2019 review paper of numerous studies on beverage service temperature with respect to both consumer preference and safety concluded that "an appropriate range for service temperatures is 130 to 160 degrees Fahrenheit."<sup>10</sup>

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<sup>3</sup> Batali, M., Ristenpart, W. & Guinard, J. (2020). Brew temperature, at fixed brew strength and extraction, has little impact on the sensory profile of drip brew coffee. *Scientific Reports*, 10(1).

<sup>4</sup> <https://www.ncausa.org/About-Coffee/How-to-Brew-Coffee>

<sup>5</sup> Delta 111

<sup>6</sup> <https://www.ncausa.org/About-Coffee/How-to-Brew-Coffee>

<sup>7</sup> Jamnadas-Khoda, B. et al. (2010). How would you like your tea, vicar? *Burns*, 36(3).

<sup>8</sup> Batali, M., Ristenpart, W. & Guinard, J. (2020). Brew temperature, at fixed brew strength and extraction, has little impact on the sensory profile of drip brew coffee. *Scientific Reports*, 10(1).

<sup>9</sup> Verst, L., Winkler, G. & Lachenmeier, D. (2018). Dispensing and serving temperatures of coffee-based hot beverages. *Ernährungs Umschau*, 65(4), 64–70.

<sup>10</sup> Abraham, J., & Diller, K. (2019). A Review of Hot Beverage Temperatures—Satisfying Consumer Preference and Safety. *Journal of Food Science*, 84(8).

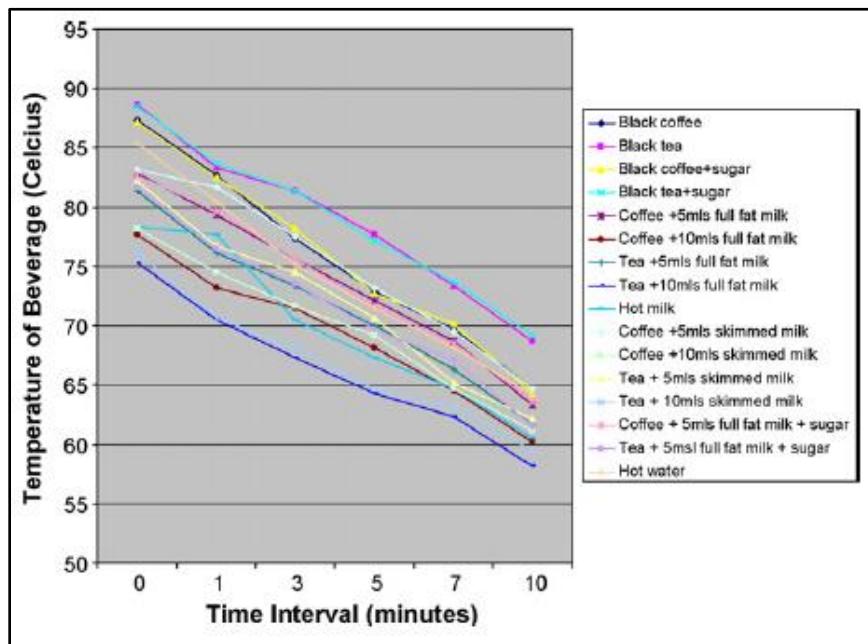


Figure 2. Heat loss of common household beverages served hot

The third aspect to consider is the temperature at which consumers prefer to drink coffee. A group of 250 college students was given cups of coffee at discrete temperatures between 135 and 195 degrees Fahrenheit and asked to rate each cup relative to their preferred drinking temperature.<sup>11</sup> The researchers of that study concluded that “coffee is ideally consumed when it is [145 to 155 degrees Fahrenheit],” while recognizing the juxtaposition that “the standard brewing and holding temperatures are too high for consumption, while the temperature identified as the medical literature threshold for burns is too low for consumption.” In a separate investigation, 300 consumers were asked to adjust coffee temperatures by using a mixing method until the coffee was at the desired drinking temperature. The reported average preferred drinking temperature was 140 degrees Fahrenheit.<sup>12</sup> Another study similarly used an iterative mixing method of adding hotter coffee to cooler coffee until the beverage was perceived to be too hot for consumption.<sup>13</sup> The results indicated that the preferred drinking temperature of coffee was 145 degrees Fahrenheit, and the average pain threshold was 153 degrees Fahrenheit. Another recent study sampled over 3,000 individual tastings between 133 and 160 degrees Fahrenheit and found that “the temperatures over the range of [136 to 151 degrees Fahrenheit] maximize consumer acceptance.”<sup>14</sup> Compiling the results of these studies presents an overall range of coffee preferred drinking temperatures to be around 140 to 150 degrees Fahrenheit, though higher temperatures are certainly preferred for some consumers.

<sup>11</sup> Borchgrevink, C., Susskind, A. & Tarras, J. M. (1999). Consumer preferred hot beverage temperatures. *Food Quality and Preference*, 10(2).

<sup>12</sup> Lee, H. S., & O'Mahony, M. (2002). At what temperatures do consumers like to drink coffee?: Mixing methods. *Journal of Food Science*, 67(7).

<sup>13</sup> Dirler, J., Winkler, G. & Lachenmeier, D. W. (2018). What temperature of coffee exceeds the pain threshold? Pilot study of a sensory analysis method as basis for cancer risk assessment. *Foods*, 7(6).

<sup>14</sup> Ristenpart, W., Cotter, A. & Guinard, J. (2022). Impact of beverage temperature on consumer preferences for black coffee. *Scientific Reports*, 12(1), 20621.



## Scalds and Burns

"Burns and scalds are damage to the skin usually caused by heat. Both are treated in the same way. A burn is caused by dry heat – by an iron or fire, for example. A scald is caused by something wet, such as hot water or steam."<sup>15</sup> Burns are typically classified into one of three categories based on depth/severity:<sup>16</sup>

- 1<sup>st</sup>-degree burn: "This minor burn affects only the outer layer of the skin (epidermis). It may cause redness and pain."
- 2<sup>nd</sup>-degree burn: "This type of burn affects both the epidermis and the second layer of skin (dermis). It may cause swelling and red, white, or splotchy skin. Blisters may develop, and pain can be severe. Deep second-degree burns can cause scarring."
- 3<sup>rd</sup>-degree burn: "This burn reaches to the fat layer beneath the skin. Burned areas may be black, brown, or white. The skin may look leathery. Third-degree burns can destroy nerves, causing numbness."

Numerous charts, graphs, and tables have been produced over the years relating the temperature and skin exposure time to result in a burn/scald injury. One such graph specifically for second-degree burns based on temperature and logarithmic exposure time was initially published in 1947 and then re-printed in a 2017 journal article review of thermal injury research (**Figure 3**).<sup>17,18</sup> This graph shows that scalds from liquids at the preferred drinking temperature of coffee (approximately 140 to 150 degrees Fahrenheit or 60 to 65 degrees Celsius), occur within just a few seconds of exposure. A recent review of the research on burn injuries also noted that the findings from that seminal 1947 research has been corroborated by other groups over the years.<sup>19</sup> The researchers pointed out that, as the graph in **Figure 3** suggests, burn injuries typically begin around 111 degrees Fahrenheit (44 degrees Celsius), and tissue damage becomes difficult to interpret beyond 158 degrees Fahrenheit (70 degrees Celsius). They cautioned that "for a given time-temperature exposure, the depth of burn injury will vary by anatomical location according to skin thickness, blood flow, and factors such as post-burn cooling." Still, the findings from this review further support that second-degree burns would occur within seconds of exposure to coffee at its preferred drinking temperature.

<sup>15</sup> <https://www.nhs.uk/conditions/burns-and-scalds/>

<sup>16</sup> <https://www.mayoclinic.org/diseases-conditions/burns/symptoms-causes/syc-20370539>

<sup>17</sup> Moritz, A. & Henriques, F. (1947). Studies of Thermal Injury: II. The Relative Importance of Time and Surface Temperature in the Causation of Cutaneous Burns. *The American Journal of Pathology*, 23(5), 695–720.

<sup>18</sup> Ye, H. & De, S. (2017). Thermal injury of skin and subcutaneous tissues: A review of experimental approaches and numerical models. *Burns*, 43(5).

<sup>19</sup> Martin, N. & Falder, S. (2017). A review of the evidence for threshold of burn injury. *Burns*, 43(8), 1624–1639.

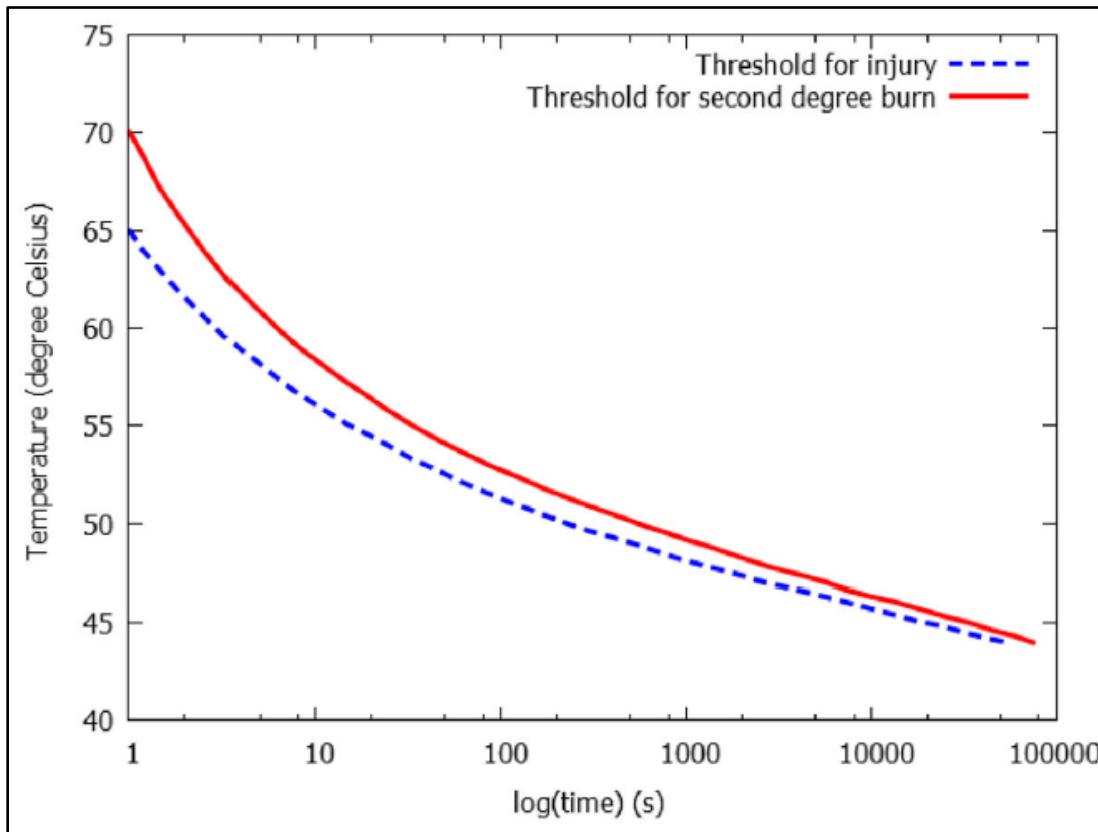


Figure 3. Thresholds for injury and second-degree burns based on temperature and exposure time

The risk of scalds from spilling hot liquids is well-known and well-understood. The American Burn Association has published a “Scald Injury Prevention: Educator’s Guide” to provide basic information on scalds in various settings and how to prevent them. It notes that “when the temperature of a hot liquid is increased to [140 degrees Fahrenheit], it takes only five seconds or less for a serious burn to occur. Coffee, tea, hot chocolate, and other hot beverages are usually served at [160 to 180 degrees Fahrenheit], resulting in almost instantaneous burns that will require surgery.” The National Coffee Association cites in its guide for brewing and serving coffee that there is a risk of burning or scalding someone when serving coffee.<sup>20</sup> In fact, instructions included with Ms. Harris’ medical records from the urgent care facility where she was treated specifically direct patients to “not leave cups, mugs, or bowls containing hot liquids at the edge of a table” as part of a risk reduction strategy for preventing second-degree burns.<sup>21</sup>

Even after given some time for hot beverages to cool, research has still found that “common household beverages,” including coffee, “have the potential to cause full thickness burns despite a period of cooling.”<sup>22</sup> Black coffee placed in an 8-ounce ceramic mug starting at a temperature of 189 degrees Fahrenheit was measured at 148 degrees Fahrenheit after 10 minutes of being in a room with an ambient temperature of 72 degrees Fahrenheit.

<sup>20</sup> <https://www.ncausa.org/About-Coffee/How-to-Brew-Coffee>

<sup>21</sup> Harris 19

<sup>22</sup> Jamnadas-Khoda, B. et al. (2010). How would you like your tea, vicar? *Burns*, 36(3).



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## Subject Incident Analysis

Based on provided documentation, Delta's standard brewing temperature range of 188 to 196 degrees Fahrenheit is consistent with, if not slightly lower than, the temperature reported in the scientific literature and industry standards for brewing coffee. There is no evidence that the coffee machinery on Ms. Harris' flight was operating abnormally. Therefore, it is likely that the coffee Ms. Harris was served just prior to the subject incident was initially brewed within this temperature range. The temperatures of the subject coffee while being transported in the carafe/canister during the breakfast service around the time of the subject incident, at the time it was poured into Ms. Harris' cup, or at the time it spilled on her are unknown. However, it is certainly reasonable to expect some amount of heat loss to occur between the time it was brewed and each of these points.

Ms. Harris also testified that she recognized that other people may prefer to drink coffee at a higher temperature than she would. Because of this, it is reasonable to expect Delta, as well as other commercial entities who serve coffee, to serve coffee at a potentially higher temperature than Ms. Harris preferred to drink her coffee. Each consumer could allow their coffee to cool to their own individual preferred drinking temperature. Ms. Harris followed this custom and practice, also sensing the coffee's temperature through taste and touch, a common practice to better understand the temperature of a hot food or beverage.

There appears to have been no issues with the handoff of the subject cup of coffee between the flight attendant and Ms. Harris. The cup was left solely in Ms. Harris' possession for at least "a minute or two" just prior to the subject incident. It is unknown what caused the cup to spill, but Ms. Harris did not testify to any specific external factors that would have caused the cup to tip. Ms. Harris testified that the liquid only spilled towards her, not to the sides or the back of the tray, suggesting that the cup tilted straight towards her.



## Conclusions

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The opinions throughout this report, including those listed below, are based on the author's education, training, and experience as well as the materials reviewed and work performed in this case.

1. The risk of a scald/burn from spilling a hot liquid is well-known, and Ms. Harris was aware of this risk.
2. The temperatures at which coffee is generally preferred to be consumed can cause a second-degree burn within seconds.
3. Ms. Harris had experience ordering and drinking hot coffee while aboard flights with Delta and other airlines.
4. Coffee prepared on Delta flights is brewed at a temperature consistent with industry standards.
5. Ms. Harris' coffee would have cooled between the time it was brewed and the time of the subject incident.
6. There is no evidence that Delta caused or contributed to the cup of coffee spilling onto Ms. Harris. She was in sole control and possession of the cup at the time of the subject incident.

ESi reserves the right to supplement or amend these findings and conclusions if additional information becomes available or based upon additional work or analysis in this matter.

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## **Appendices:**

Appendix A: File materials received

Appendix B: CV of David M. Fortenbaugh, Ph.D.

Appendix C: Testimony List of David M. Fortenbaugh, Ph.D.

# APPENDIX A

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## FILE MATERIALS RECEIVED

### **DATA RECEIVED**

- Injury Photos [Delta 8,14; Harris 1-15]

### **LEGAL**

- Complaint
- Plaintiff's Initial Disclosures
- Plaintiff's Resp to Def First Rogs and RFP

### **DEPOSITIONS**

- Melba Harris

### **MEDICAL RECORDS**

- Beaumont Urgent Care [Harris 16-51]

### **PRODUCT USER MANUALS**

- Coffee Maker Manual [Delta 111]

### **EXTERNAL CORRESPONDENCE**

- Letter of Retention [Delta 5-7]
- Delta Emails [Delta 9-13, 15-20, 22-25]
- Settlement Package Letters [Delta 26-108]
- Change of Adjuster Letter [Delta 21]

### **OTHER**

- Delta Boarding Pass [Harris 52-53]
- Delta Passenger Lookup [Delta 1-4]
- Delta Crew Verification [Delta 109]
- Delta Flight Information [Delta 110]
- Delta Cabin Reliability Index [Delta 112-119]
- Delta Service Standards [Delta 121-124]

# APPENDIX B

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5575 Tech Center, Suite 115  
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## DAVID M. FORTENBAUGH, Ph.D.

### SENIOR CONSULTANT

[dmfortenbaugh@engsys.com](mailto:dmfortenbaugh@engsys.com)

Dr. Fortenbaugh is a consultant and project manager for matters related to product liability, premises safety, and accident reconstruction. He specializes in the human factors and biomechanics/injury aspects of accidents. He has forensically investigated over 800 accidents, including over 150 falls following a slip, trip, or misstep. He has extensive experience in multidisciplinary studies of automotive and marine accidents and with incidents involving consumer and industrial products. Dr. Fortenbaugh routinely evaluates human interaction with sports and fitness equipment, medical devices (e.g., wheelchairs and walkers), and climbing products (e.g., ladders and stepstools). He examines issues of workplace safety, warnings and instructions, and human motion analysis including occupant kinematics. He is also active in the development of safety standards and serves in leadership roles in professional societies.

Prior to joining ESI, Dr. Fortenbaugh worked extensively with athletes and medical professionals for over 10 years to improve human performance and reduce injury. His previous research focused on the biomechanical analysis of both basic and sports-specific movements, effectiveness of surgical techniques through cadaver testing, and clinical outcomes following orthopedic surgery. Dr. Fortenbaugh has presented his research findings at numerous national and international scientific conferences and has published more than a dozen peer-reviewed journal articles. He also contributes as a reviewer for such publications.

### Areas of Specialization

Biomechanical Accident Reconstruction  
Human Factors / Ergonomics  
Sports and Fitness Equipment  
Warnings, Instructions, and Safety Labeling  
Medical Devices  
Slips, Trips, and Falls  
Visibility and Conspicuity  
Product Safety and Design  
Injury Analysis  
Industrial and Workplace Safety  
Risk Assessment and Hazard Analysis

### Education

Ph.D., Ergonomics, University of Miami, 2011

M.S., Movement Science, Biomechanics Specialization, Barry University, 2005

B.S., Biomedical Engineering, Yale University, 2003

December 2022



## Positions Held

### **Engineering Systems Inc., Colorado Springs, Colorado & Fort Myers, Florida**

Senior Consultant (2021 – present)  
Senior Staff Consultant (2018 – 2021)  
Staff Consultant (2014 – 2018)

### **Motus Global, Bradenton, Florida**

Executive VP, Biomechanics Research and Development (2012 – 2013)

### **American Sports Medicine Institute, Birmingham, Alabama**

Biomechanist (2007 – 2012)

## Selected Technical Investigations

Design and evaluation of on-product safety labels and owner's manuals  
Visibility / glare / distraction of motorcycle and locomotive headlights  
Bathtub design evaluation  
Sports and fitness equipment  
Amusement park attractions, waterslides, and other recreational land and water sports  
Medical devices (wheelchairs, walkers, etc.)  
Worker and patient safety in healthcare facilities  
Consumer products (household appliances, toys, lawnmowers, etc.)  
Night-time visibility / conspicuity and visibility obstructions  
Automotive human factors  
Occupant protection in cars, heavy trucks, off-road vehicles, and construction equipment  
Biomechanical analysis of low-speed motor vehicle crashes  
Motorcycle and bicycle helmets  
Pedestrian / vehicle and bicycle / vehicle crashes  
Manual material handling  
ADA / OSHA  
Ladders, stairways, and falls from heights  
Machine and furniture tip-overs  
Hot liquid spills  
Slips, trips, and missteps in various environments (retail, industrial, residential, etc.)



## Continuing Education

Forklift Training, J.J. Keller (2022)

Walkway Auditor Certificate Holder (WACH), National Floor Safety Institute (2021)

Neuroradiology 101, AAAM (2021)

Preventing Falls in the Workplace, International Ergonomics Association (2021)

Child Safety: The New Decade and Beyond, AAAM (2021)

OSHA 30 Hour Outreach Training Program – Construction, 360 Training (2021)

Behind the Scenes Look at an IIHS Crash Test, AAAM (2020)

Recent Developments at the US CPSC, Sports and Fitness Industry Association (2019)

ADA Basic Building Blocks Course, ADA National Network (2019)

Human Factors in Traffic Crash Reconstruction, IPTM (2017)

Understanding Bloodstain Pattern Analysis, Bevel, Gardner & Associates (2017)

Certified XL Tribometrist (CXLT), Excel Tribometers, LLC (2016)

Course on Injury Scaling: Uses and Techniques, AAAM (2015)

Traffic Crash Reconstruction 1, Northwestern University (2014)

## Professional Affiliations/Honors

### American Society for Testing and Materials (ASTM) International

Member, E34 – Occupational Health and Safety (2015 – present)

Member, F08 – Sports Equipment, Playing Surfaces and Facilities (2014 – present)

Member, F13 – Pedestrian/Walkway Safety and Footwear (2014 – present)

Member, F15 – Consumer Products (2018 – present)

Member, F24 – Amusement Rides and Devices (2019 – present)

Member, F25 – Ship and Marine Technology (2020 – 2021)

Member, F27 – Snow and Water Sports (2021 – present)



#### **Association for the Advancement of Automotive Medicine (AAAM)**

Chair, Policy Committee (2020 – present)  
Vice Chair, Policy Committee (2019 – 2020)  
Member, (2016 – present)

#### **American National Standards Institute (ANSI)**

Member, A14.5 Subcommittee on portable reinforced plastic ladders (2021 – present)  
Member, A14.11 Subcommittee on stepstools (2021 – present)

#### **American Orthopedic Society for Sports Medicine**

O'Donoghue Sports Injury Research Award (2013)

#### **American Society of Safety Professionals (ASSP)**

Professional Member (2022 – present)

#### **American Sports Medicine Fellowship Society**

Clinical Science Award (2011)  
Basic Science Award (2008, 2011)

#### **Human Factors and Ergonomics Society (HFES)**

President, University of Miami Chapter (2006 – 2007)  
Member, (2016 – present)  
Reviewer

#### **International Society of Biomechanics in Sports (ISBS)**

Director (2009 – 2011)  
Member (2004 – 2012)

### **Professional Activities**

American Journal of Sports Medicine, Reviewer  
International Journal of Industrial Ergonomics, Reviewer  
International Journal of Sports Science & Coaching, Reviewer  
Journal of Applied Biomechanics, Reviewer  
Journal of Motor Behavior, Reviewer  
Journal of Shoulder and Elbow Surgery, Reviewer  
Journal of Sports Sciences, Reviewer  
Perceptual and Motor Skills, Reviewer  
PLOS ONE, Reviewer  
Sports Biomechanics, Reviewer  
Sports Health, Reviewer

#### ARC-CSI Crash Conference

Pedestrian Crash Research Team (2017)



Human Factors and Ergonomics Society  
 "Reducing Risk through Design" session chair (2017)

## Publications/Presentations

"Flip-Flops: A Survey of Risk Perception and Acceptance", **D. Fortenbaugh**, P. Shibata, M. Meza-Arroyo, K. Thobe and T. Welch. Proceedings of the Human Factors and Ergonomics Society, 2022.

Beyond the Horizon of Consumer Communications. ICPHSO International Virtual Symposium: The Safety Horizon: International Perspectives on the Future of Consumer Product Safety, 2021.

"A Methodology for Assessing Driver Perception-Response Time during Unanticipated Cross-Centerline Events", L. Rixinger and **D. Fortenbaugh**, Traffic Injury Prevention, 2021.

These Issues Will Get Your Heart Rate Up: Fitness Equipment. CLM Focus: Diversity & Inclusion, Product Liability, Transportation, Claims & Litigation, Webcast, June 25, 2020.

"Validation of the Han-Brach Vehicle-Pedestrian Impact Mechanics Model", R. M. Brach, **D. Fortenbaugh** and J. van Poppel, Collision Magazine, volume 13, issue 2, pgs. 8 – 23, Spring 2020.

"A Parametric Study of an Adaptive Load-Limiting Restraint System with Weight Sensing Considerations" J. van Poppel, A. Stern, **D. Fortenbaugh**, and G. Wilcox. 26<sup>th</sup> ESV, Eindhoven, Netherlands, 2019.

"Changes in Youth Baseball Pitching Biomechanics: A 7-Year Longitudinal Study" G. Fleisig, A. Diffendaffer, B. Ivey, K. Aune, T. Laughlin, **D. Fortenbaugh**, B. Bolt, W. Lucas, K. Moore and J. Dugas. American Journal of Sports Medicine, 2017.

"Long-Term Outcomes after Ulnar Collateral Ligament Reconstruction in Competitive Baseball Players: A Minimum of 10 Years Follow-up" D. Osbahr, L. Cain, **D. Fortenbaugh**, B. Raines, J. Dugas and J. Andrews. American Journal of Sports Medicine, 2014.

"Trunk Axial Rotation in Baseball Pitching and Batting" G. Fleisig, W. Hsu, **D. Fortenbaugh**, A. Cordover and J. Press. Sports Biomechanics, 2013.

"Dynamic Ultrasonography: A Cadaveric Model for Evaluating Aseptic Loosening of Total Ankle Arthroplasty" P. Ryan, **D. Fortenbaugh**, M. Downey and J. Kirchner. Journal of Foot and Ankle Surgery, 2013.



"Back Squat Comparison of Barefoot and Shoe Conditions" K. Sato, **D. Fortenbaugh**, D. Hydock and G. Heise. International Journal of Sports Science and Coaching, 2013.

"Kinematic Changes Using Weightlifting Shoes on Barbell Back Squat" K. Sato, **D. Fortenbaugh** and D. Hydock. Journal of Strength and Conditioning Research, 2012.

Pathology of Baseball Pitching: Biomechanics and Epidemiology. Seventh Annual Coaches and Sport Science College, East Tennessee State University, USA, December 15, 2012.

"The Effect of Pitch Type on Ground Reaction Forces in the Baseball Swing" **D. Fortenbaugh**, G. Fleisig, A. Onar-Thomas and S. Asfour. Sports Biomechanics, 2011.

"Biomechanical Comparison of Baseball Pitching and Long-Toss: Implications for Training and Rehabilitation" G. Fleisig, B. Bolt, **D. Fortenbaugh**, K. Wilk and J. Andrews. Journal of Orthopedic and Sports Physical Therapy, 2011.

Elbow Biomechanics & Pathomechanics. ASMI Weekly Conference, Birmingham, AL, USA, September 2, 2011.

Coming Down: Throwing Mechanics of Baseball Catchers. ASMI Injuries in Baseball Course, Tampa, FL, USA, January 29, 2011.

Elbow Biomechanics & Pathomechanics in Pitching. ASMI Injuries in Baseball Course, Tampa, FL, USA, January 29, 2011.

Pitching Biomechanics and Epidemiology. Jefferson County High School Baseball Coaches Meeting, Kimberly, AL, USA, November 4, 2010.

Elbow Biomechanics & Pathomechanics. ASMI Weekly Conference, Birmingham, AL, USA, September 3, 2010.

Coming Down: Throwing Mechanics of Baseball Catchers. International Society of Biomechanics in Sport Conference, Marquette, MI, USA, July 22, 2010.

The Effects of Weightlifting Shoes on Squat Kinematics. International Society of Biomechanics in Sport Conference, Marquette, MI, USA, July 20, 2010.

Biomechanics of Baseball Batting. ASMI Injuries in Baseball Course, Birmingham, AL, USA, January 24, 2010.

Elbow Biomechanics & Pathomechanics in Pitching. ASMI Injuries in Baseball Course, Birmingham, AL, USA, January 23, 2010.



"Effects of the Bench Shirt on Sagittal Bar Path" T. Silver, **D. Fortenbaugh** and R. Williams. Journal of Strength and Conditioning Research, 2009.

"Baseball Pitching Biomechanics in Relation to Injury Risk and Performance" **D. Fortenbaugh**, G. Fleisig and J. Andrews. Sports Health: A Multidisciplinary Approach, 2009.

Elbow Biomechanics & Pathomechanics. ASMI Weekly Conference, Birmingham, AL, USA, September 28, 2009.

Mechanical Efficiency in Baseball Pitching. International Society of Biomechanics in Sport Conference, Limerick, Ireland, August 20, 2009.

Do Biomechanical Evaluations Help? ASMI Injuries in Baseball Course, Houston, TX, USA, January 25, 2009.

Elbow Biomechanics & Pathomechanics in Pitching. ASMI Injuries in Baseball Course, Houston, TX, USA, January 24, 2009.

Elbow Biomechanics & Pathomechanics. ASMI Weekly Conference, Birmingham, AL, USA, September 5, 2008.

Head Motion during Baseball Pitching. North American Congress on Biomechanics. Ann Arbor, MI, USA, August 8, 2008.

Ballpark Forces: Ground Reaction Forces During Batting. International Society of Biomechanics in Sport Conference. Seoul, South Korea, July 15, 2008.

Incorporating Dartfish into a Sports Camp. Southeastern Meeting of the American Society of Biomechanics. Birmingham, AL, USA, April 28, 2008.

The Biomechanics of Baseball Pitching: Shoulder & Elbow. Samford University, Birmingham, AL, USA, February 8, 2008.

"The Biomechanics of Situational Baseball: Execution and Perception of Left-Handed Pitchers' Simulated Pick-Off Moves to First Base" **D. Fortenbaugh** and M. Butcher-Mokha, Sports Biomechanics, 2007.

25 Years of the ISBS: A Silver Salute to Sports Biomechanics Presentations. International Society of Biomechanics in Sport Conference. Ouro Preto, Brazil, August 26, 2007.

Differences in Angular Velocity Among Selected Kinematics During a Left-Handed Pitchers' Pick-Off Move. International Society of Biomechanics in Sport Conference. Salzburg, Austria, July 15, 2006.



Selected Kinematic Comparisons Between Football Quarterbacks and Baseball Catchers at Maximum External Rotation of the Shoulder. Southeast Biomechanics Conference. Atlanta, GA, USA, April 1, 2006.

Deliveries to Home Plate and First Base Made by Left-Handed Pitchers. International Society of Biomechanics in Sport Conference. Ottawa, Canada, August 10, 2004.

## Patents

### United States Patent:

**Patent No.** 10,314,536

**Patent Title:** Method and system for delivering biomechanical feedback to human and object motion

# APPENDIX C

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<b>PROJECT</b>	<b>STATE</b>
<b><u>2022</u></b>	
<b>Stubing v. Sports Imports Corp., et al</b> No. 19 L 002555 Circuit Court of Cook County, State of Illinois	IL (Deposition)
<b>Tranen (Stephanie) v. Wild Flower Restaurant &amp; Catering</b> No. 2022-CC10188 Circuit Court of St. Louis City, State of Missouri	MO (Deposition)
<b>Mizrahi v. Miami Lakes United Methodist Church</b> No. 2020-018556 CA01 (CA02) Circuit Court of the 11th Judicial District, Miami-Dade County, FL	FL (Deposition)
<b>Van Kampen v Lakeland Regional Medical Center</b> No. 2019-CA-001901 Circuit Court of the Tenth Judicial Circuit, Polk County, FL	FL (Trial)
<b>Bull v Superior Mobility, Inc., et al</b> No. BC687919 Superior Court, Los Angeles County, California	CA (Deposition)
<b><u>2021</u></b>	
<b>Frances Schneider v Royal Gorge Bridge and Park</b> No. 19CV030018 District Court, County of Fremont, Colorado	CO (Trial)
<b>Van Kampen v Lakeland Regional Medical Center</b> No. 2019-CA-001901 Circuit Court of the Tenth Judicial Court, Polk County, FL	FL (Deposition)
<b><u>2019</u></b>	
<b>Fishman v Neapolitan Enterprises, LLC</b> No. 11-2017-CA-001377 Circuit Court of the 20th Judicial Circuit, Collier County, FL	FL (Deposition)
<b>Deal v Drive Devilbliss Healthcare</b> No. 2014-CV-056 US District Court of Georgia, Statesboro Division	GA (Deposition)
<b><u>2018</u></b>	
<b>White v Heritage Lake Park Community Development District</b> No. 16001824CA Circuit Court of the 20 <sup>th</sup> Judicial Circuit, Charlotte County, Florida	FL (Deposition)